



Chicken Egg Detection Based-on Image Processing Concept: A Review

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ABSTRACT



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The concept of image processing has been implemented and developed in various fields, including the poultry industry. The focus in development is on egg detection. Detection is not only in the concept of object detection but also in other things such as weight prediction, egg physical characteristics, to embryo detection. This staged process starts from the image acquisition process, preprocessing, segmentation up to identifying or detecting eggs. This article provides details about the concept of image processing in detecting chicken eggs based on a review of previous studies. The studies discussed the basic concepts of image processing in detecting chicken eggs and their technical application. Based on image processing's basic concept, there are four main parts: image acquisition, preprocessing, segmentation, and identification or classification. The acquisition process is carried out with a variety of tools that can capture images to be processed. The result of the acquisition is preprocessed by one or more methods that can improve image quality. After that, the image segmentation process is used to determine the object to be detected. Image segmentation can be used as a reference for objects processed by feature extraction. The feature extraction aims to provide certain fertile (embryonic) characteristics and unfertile (non-embryonic) egg images. The identification process is precise which objects are detected and not. The concept of segmentation and identification/classification can be implemented in computer-based applied applications. Besides, these methods are still developing and improving their accuracy and implementation in the poultry industry.

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1. Introduction

The development of technology in the poultry industry has become a trend and is still under development [1], [2]. At this time, technological developments made a significant contribution to egg identification resulting in increased production. One of the developing technologies uses the concept of image processing. This concept has been researched and applied in various detection

processes or identification of eggs [3] - [5]. Image processing is carried out starting from image acquisition, preprocessing, segmentation to identification/classification.

Research related to egg image detection is carried out with a focus on segmentation and identification methods. As for the process of image acquisition and preprocessing, several techniques and methods are used. The acquisition is carried out using various tools, such as digital cameras, smartphone cameras, and thermal cameras, with each process being carried out. The process is carried out directly by taking pictures or with tools such as irradiation (for candling) [6], [7]. This process aims to digitize objects. So the results obtained are digital images that are used for the detection/identification process. The detection/identification is processed using the physical and non-physical characteristics of the eggs. Physical characteristics of eggs that have been studied include color [8], [9], texture [10], size [11], eggshell characteristics [12] and object detection [13] - [15] and embryos [6], [7], [9], [16] based on the radiation process. While the non-physical characteristics can be temperature [15], [17] - [19] which is obtained based on the energy emission produced by the egg.

Research using the segmentation process in embryonic egg images uses three-dimensional differential interference contrast (DIC) images. The method used is based on the shape index and ellipsoid-fitting method [20]. In addition, researchers have conducted previous research regarding the identification of eggs both physically and non-physically. Egg-related research identifies eggs using thermal acquisition imaging [14] and a smartphone camera [21]. The identification process of preprocessing by cropping method [11], image enhancement [16], [22] with histogram equalization, feature extraction [23] - [25], segmentation [13], [16], [22], [26], and identification of egg fertility [16], [23] - [25], [27]. This research is a development with the segmentation method, which is different from applying the method using the K-means algorithm.

In this concept, many criteria are referred to contribute to maximizing egg productivity. Criteria used such as selection of early eggs before hatching, which describes the condition of the eggs (age before seven days [28]) and cleanliness of eggs [29], [30]. In addition, the process of identifying the successful development of egg embryos in an incubator. The process of checking embryos uses a candling process on eggs more petite than a week old in a hatching machine [31]. The process of identifying the presence of egg embryos is carried out by various methods ranging from temperature detection using thermal imaging [21], [32], [33] and hyperspectral imaging [34], [35], to detection of embryos with digital cameras on irradiated eggs (candling) [36]. This candling process aims to determine the state of the egg's contents (whether there is an embryo in the egg). Early embryo detection of eggs in the hatching process is carried out to select the initial eggs. Unfertilized eggs can be used for consumption because they are still good.

Many image processing problems are solved by segmentation, the animal husbandry sector [37] - [43]. Commonly used segmentation methods include threshold segmentation (such as the Otsu method, the minimum error method, and the iteration method), edge detection using operators such as Sobel, Prewitt, Roberts, and LOG), and region segmentation (region). using region generation [21]. Image segmentation is beneficial in the detection of embryonic egg regions. Image segmentation is part of image processing, aiming to divide the image into several parts [45], [46]. Image segmentation can be done using grayscale or color images [47]. The segmentation process is the 3rd stage of the image processing stage, after acquisition and preprocessing. In this process, the egg area is divided into outer, inner, white, and yolk—identification of the embryo in the inner egg with the condition that the egg yolk has an embryo. The embryonic yolk is characterized by the presence of branches or roots or like a net.

In this article, the author reviews articles related to the detection of chicken eggs using the concept of image processing. The review method is presented in section 2. The results of the review and discussion are presented in section 3, which explains the application of image processing

2. Method

This article is a review article about the detection of chicken eggs using the concept of image processing. This article uses papers in both journals and proceedings. The articles used were taken

from indexed online sources such as IEEEXplore, Science Direct, Springer, Scholar, and others (apart from these journals). The details of this review process are shown in Figure 1.

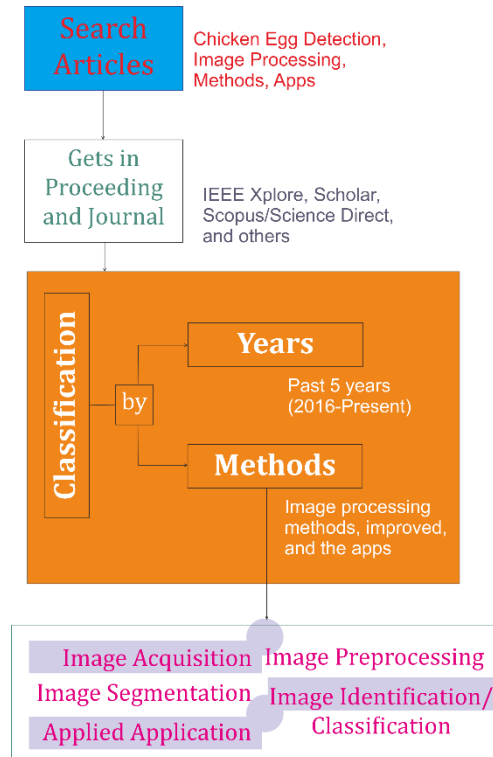


Fig. 1. Review articles and their classification process

In this study, the focus of research is on image processing used in egg detection. This detection uses data from chicken eggs. The concept of image processing used is the basic concept starting from image acquisition, image preprocessing, segmentation, image identification/classification. The data used details for the review are described in this section, including the concept of image processing in egg detection.

2.1. Data Collection and Preparation in Egg Detection Research

The research data is in the form of images of chicken eggs obtained from various acquisition processes. The data used by researchers related to egg detection was carried out using primary and secondary data. The primary data used is based on the acquisition process, which is processed by the researchers themselves in obtaining images of chicken eggs. In addition, other researchers use secondary data, data obtained from datasets on internet sources. The data used by the researchers was chicken egg data, and some were compared with eggs from other poultry, such as ducks.

In addition, studies in this detection use preparations using other tools and software.

2.2. Image Processing Concept in General Perspective

The image processing concept used in this review article is general. Image processing is the image up to the segmentation, feature extraction, and identification or classification process. In general, the concept of image processing can be shown in Figure 2.

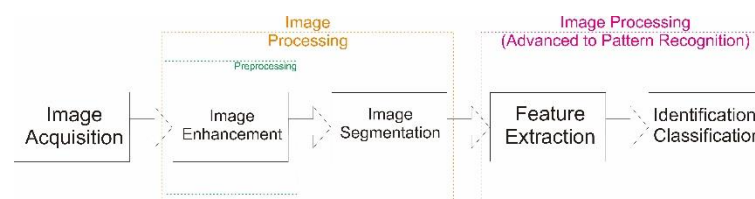


Fig. 2. The concept of image processing, in general, is in the detection process

In the concept of image processing, the first step is image acquisition. Image acquisition is the initial stage in obtaining digital images. The acquisition process is used in determining the required data and selecting the digital image recording method. The stages begin with the image object, the preparation of the tools for the imaging. Imaging is an activity to transform visible images (such as photographs, drawings, paintings, landscapes, sculptures) into digital images.

Image quality improvement is a preprocessing stage in image processing that is carried out to improve the quality of an image. The indicator of a good image is the result of segmentation. The segmentation is a stage that aims to partition/divide the image into several main parts containing necessary information. The recognition of objects in images requires parameters that can characterize these objects. Characteristics that can differentiate objects from one another are shape, size, geometry, texture, and color.

The identification/classification process uses the parameter values of the object characteristics of each class as input data. The data will be processed in order to obtain a formula that can recognize the object. The process of identifying/classifying objects requires two main processes, namely training and testing. The training process is carried out using training data which contains feature parameters to differentiate one object from another. The training process will map the training data towards the training target through a particular formula (algorithm).

3. Results and Discussion

This study resulted in a review of articles from previous studies. The review process uses basic concepts in image processing. The review is carried out based on image processing and its development both with feature extraction and detection/identification based on computer vision.

3.1. Image acquisition in chicken detection (tools, process, and results)

The acquisition process is carried out using many tools such as digital cameras. However, along with technological developments, many acquisitions are also carried out using smartphone cameras. In addition, this process was also investigated using thermal and hyperspectral cameras.

Image acquisition of chicken eggs was carried out under various conditions. The first condition is that the picture of eggs is immediately taken using a digital camera or smartphone camera. In addition, the use of digital cameras/smartphones is also carried out in conditions of candling in a dark place or a box. The acquisition process produces a digital image with an image of the object as captured by the camera. So that this concept only digitizes objects for image processing. The acquisition process of thermal cameras [18], [21], [32], [33] is carried out as usual as with other cameras, but the resulting image transmits the emission of temperature/heat produced by the egg. This process can be seen in Figure 2.

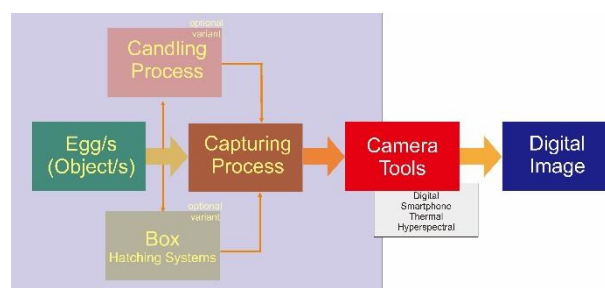


Fig. 3. Konsep image processing secara umum dalam proses deteksi oleh peneliti terdahulu

The result of the acquisition is a digital image that is used as input in image processing. Image acquisition on each tool produces a different image. Image with the acquisition process using a digital image and/or a smartphone camera has the same concept.

3.2. Image preprocessing in egg detection (methods and results)

After the egg image is obtained from the acquisition process, the following process is preprocessing. Preprocessing is done to get a better image than the acquisition image for the following process. Many preprocessing techniques have been carried out, both primary and developed. Preprocessing is done in various ways, such as using histogram equalization [16], [48] to improve the image based on the appearance of the histogram produced by the image.

3.3. Image Segmentation Process

Segmentation in image processing is used in egg detection, both the egg object itself and other objects as a sought-after feature. Image segmentation methods widely used in detecting chicken eggs include thresholding, otsu, k-means, etc.

3.4. Image Identification of Chicken Eggs

The identification process is carried out using feature extraction parameters. Before the identification process, the characteristic extraction of the image is calculated using feature extraction methods which are the input in the identification process.

3.5. Applied Application for Image Egg Detection

Egg detection is implemented in several image processing concepts and developments. The application uses segmentation and identification/classification methods. The segmentation method used in egg detection applications includes [49] applying the Connected Component Labeling algorithm.

Application of egg detection applications with various concepts and analysis following existing needs in the poultry sector. Applications for weight and volume detection of poultry using computer vision concepts have been reviewed [50]. This application can perform the classification, measurement, sorting, and grading of poultry products.

4. Conclusion

This review article examines the application of image processing in egg detection in the poultry sector, including the process and development steps. Many studies have focused on detecting chicken eggs with the highest accuracy, close to 100%. Image processing algorithms have been developed in egg detection, starting from physical characteristics and egg embryo development. The method developed has evolved to the concept of deep learning and machine learning. In addition, this research is still being developed using improved machine learning methods to get the best detection results that can be implemented in poultry.

Table 1. Review of previous studies on chicken egg detection

Year	Author	Data/sample	Methods	Category	Main Results
2020	Koodtalang et al. [51]	Chicken egg			
2020	Cirua et al. [49]	Chicken Egg was taken by a camera	Connected Component Labeling algorithm, Threshold process, segmentation, and measurement of the object's egg scale	Smart systems, image processing, segmentation	The trial results show that the object image of an egg is strongly influenced by the size of the image, the intensity of the light, and distance of capturing images.
2020	Fadchar et al. [52]	Captures image of a five (5) day old chicken egg (150 images)	Threshold segmentation, RGB color converted, Neural Network	Image Processing, Segmentation, Classification	The predictive model has an over-all accuracy of 97%. The predictive model has a lower mistake ratio

Year	Author	Data/sample	Methods	Category	Main Results
					compared to the prediction made through manual candling process.
2020	Narushin et al. [53]	40 fresh chicken eggs were purchased from Woodlands Farm, Canterbury and Staveley's Eggs Ltd, Coppull, UK	Hügelschäffer's model, contours of the hens' eggs and recalculating their geometrical variables	Non-destructive measurement Automated systems	Its applicability and validity for measuring eggs
2020	Okinda et al. [54]	1500 fresh Brown Chicken Eggs (private)	Contour curvature analysis and k-closest M-circle-center algorithms, Regression model	Image Segmentation	System can implementate the sorting technique of chicken eggs by volume estimation
2021	Saifullah, S [9]	Chicken egg on hatching egg systems	K-means Segmentation, L*a*b color space, grayscale, Histogram Equalization, morphology	Image Segmentation, Image Processing	K-means segmentation based on L*a*b color space can be used for the initial stages of the embryo detection process.
2021	Chang et al. [55]	30 breeding egg on the hatching using thermal imaging	Artificial Incubation System, IoT sensing system, machine learning, digitalization, and intelligence of the hardware and software of the waterfowl industry chain	Image and Sensor Processing	Reintegrated a complete set of intelligent detection and application improvement solutions, which can enhance the digitalization and intelligence of the hardware and software of the waterfowl industry chain.
2021	Mollazade et al. [56]	450 chicken egg	3D-laser scanning, Multi-layer Perceptron Neural Network, wavelength region, 2D shape analysis	Neural networks, Leser Scanning	Egg internal quality can be identified by 3D laser imaging, and better than 2D shape analysis
2021	Toksoz et al.[57]	262 chicken eggs recorded on 20-24 °C temperatures	ATAK-S feature, Shape index, random forest classifier	Image Processing Data mining	Chicken egg sexing can be classified by data mining (random forest)
2021	Nyalala, et al. [50]	Others studies	Review	Non-destructive measurement Classification	Review of challenges and potential future trends in size, weight, and volume estimation of poultry production

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